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ABSTRACT

The pilot study evaluated a 10-week academic cognitive training program in 12 stimulant-treated hyperactive boys (6-11 years old). Training components included self monitoring and self reinforcement of problem solving behaviors, the exclusive use of academic tasks and materials, and correspondence training. Significant improvement was found in Wide Range Achievement Test reading scores and in reading comprehension on the Stanford Achievement Test. Ss performed significantly better than a no treatment control group on an academic skills test comprised of task instructions more varied than those on standardized achievement tests. Findings provide support for large-scale, controlled investigations of the efficacy of academic cognitive training as an adjunct to stimulants in underachieving and learning-disordered hyperactive children. (Author/CL)

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Academic Cognitive Training and Stimulants in Hyperactivity:
A Pilot Study

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Abstract

This pilot study evaluated a 10 week academic cognitive training program in 12 stimulant treated hyperactive boys. Training components included self-monitoring and self-reinforcement of problem-solving behaviors, the exclusive use of academic tasks and materials, and correspondence training. Significant improvement was found in WRAT Reading scores and in Reading Comprehension on the Stanford Achievement Test. The children performed significantly better than a no treatment control group on an academic skills test comprised of task instructions more varied than those on standardized achievement tests. The findings provide encouraging support for large-scale, controlled investigations of the efficacy of academic cognitive training as an adjunct to stimulants in underachieving and learning disordered hyperactive children.

Hyperactivity (Attention Deficit Disorder with Hyperactivity, ADDH, DSM-III, American Psychiatric Association, 1980), is a behavioral disorder of childhood characterized by the primary symptoms of inattentiveness, impulsivity, and restlessness.

Scholastic difficulties, such as poor performance on standardized achievement tests, and school failure, are associated frequently with the disorder: prevalence estimates of learning disabilities greater than 40% have been reported in ADDH children (Lambert & Sandoval, 1980). Recent evidence indicates that inefficient problem-solving skills (Tant & Douglas, 1982) and inadequate perceptual search strategies (see Douglas, 1980) are also common in ADDH youngsters. It is likely that such deficits compound their academic difficulties, since these cognitive/perceptual functions are essential components of efficient learning and study skills.

The most widely used treatment with hyperactive children continues to be psychostimulant medication. The short-term clinical efficacy of these drugs (methylphenidate, dextroamphetamine, magnesium pemoline) has been well documented (see reviews by Barkley, 1977; Klein, Gittelman, Quitkin, & Rifkin, 1980; Whalen & Henker, 1976). With medication, a large proportion of youngsters (estimated from 60-90%, Whalen & Henker, 1980) demonstrate substantial clinical improvement in the primary symptoms of the disorder.

The efficacy of medication in improving academic functioning is less well established. Stimulants appear to have little impact on such global aspects of cognition as reasoning, problem-solving and learning (Campbell, 1976). A recent review concludes that while

stimulants may increase academic productivity in some children, its impact on academic achievement is considerably less promising (Gadow, 1983).

There has been increasing awareness that drug treatment of ADDH children with learning problems needs to be supplemented with educational interventions (Rie, Rie, Stuart & Ambuel, 1976; Sprague, 1981; Werry, 1981). There is a paucity of information, however, as to the efficacy of specific tutorial/remedial approaches with this population (see Conrad, Dworkin, Shai, & Tobiessen, 1971; Satterfield, Satterfield, & Cantwell, 1981).

Recently, cognitive training has been suggested as a potentially useful intervention for improving the academic functioning of ADDH children (Douglas, 1980). Under the cognitive training rubric are such procedures as self-instructional training, cognitive modeling, self-monitoring, self-reinforcement, and training in attention scanning and deployment (see Meichenbaum, 1977).

In the prototypical cognitive training study with hyperactive children, the behaviors targeted for change are the children's inefficient, impulsive problem-solving skills. Cognitive trainers model reflective problem-solving strategies and, through self-instructional training, teach the children to use overt and subsequently covert self-statements to guide, monitor, and reinforce their performance on psychoeducational and perceptual-motor tasks. Invariably, academic tasks and materials are omitted from the training regimen. This approach has resulted generally in improved performance, in the direction of increased reflectivity, on measures of cognitive impulsivity such as the Matching Familiar Figures Test and Porteus Mazes (see Bugental, Whalen, & Henker, 1977; Douglas, Parry, Marton,

& Garson, 1976; Moore & Cole, 1978; Palkes, Stewart & Kahana, 1968; Palkes, Stewart, & Freedman, 1972).

A handful of cognitive training studies with ADDH children have included indices of academic achievement among their outcome measures. The results of these investigations with nonmedicated youngsters have been equivocal. Friedling & O'Leary (1979) found no improvement on reading and math performance following 90 minutes in self-instructional training. Limited improvement in reading skills was demonstrated by Douglas et al., (1976) and Watson and Hall (Note 1). A large-scale random assignment investigation of cognitive training in 50 medicated hyperactive children found no evidence for the superiority of this approach over medication alone, or medication plus attention control, in improving academic achievement (Abikoff & Gittelman, Note 2).

In summary, it appears that cognitive training in nonacademic, reflective skills, generalizes only to tasks similar to those used in training. To maximize improvement in academic functioning it seems necessary to focus specifically on academic skills and tasks problematic for the child, and to teach academically relevant skills strategies; a position held also by others (Douglas, 1980; Kauffman & Hallahan, 1979; Meichenbaum & Asarnow, 1979). Direct support for this contention is found in a recent study by Cameron & Robinson (1980), who evaluated an academically based cognitive training program with three nonmedicated, hyperactive, academically backward eight year olds. Within a multiple-baseline design, the twelve half-hour sessions emphasized self-instructional strategies for math problems and self-reinforcement for correct math performance. At posttreatment, accuracy of classroom math assignments had significantly improved for all children.

Studies with other populations provide additional support for the utility of academically oriented cognitive training. Improved reading comprehension has been reported in slow readers (Bommarito & Meichenbaum, 1978, cited in Meichenbaum & Asarnow, 1979) and in educable mentally retarded children (Note 3). Impulsive children have shown significant improvements in their WRAT reading and arithmetic scores (Glenwick & Barocas, 1979). The findings from single-subject designs indicate enhanced arithmetic skills as a result of attack strategy training (Grimm, Bijou & Parsons, 1973) and training in overt verbalization of number sentences (Lovitt & Curtis, 1968). Single-subject studies have also shown handwriting accuracy (Note 4) and word reading accuracy (Note 5) to be facilitated by self-instructional training.

The rationale for incorporating self-monitoring and self-reinforcement in cognitive training programs for hyperactive children is well founded (see Douglas, 1980). The choice of which target behaviors to monitor and reinforce during training (e.g., non-disruptive on-task behavior, [Barkley, Copeland & Sivage, 1980], length of time on task, [Varni & Henker, 1979]) is less well established, and has had mixed effects on academic performance. The goal of cognitive training is to provide children with more effective problem-solving strategies which will operate as mediators to guide and direct academic performance. Accordingly, the behaviors targeted for self-monitoring and self-reinforcement should include those relevant to the problem-solving process (e.g., the generation of appropriate self-instructions to aid in problem identification). The production of correspondence between cognitive planning strategies, (i.e., a statement of what one intends to do) and one's subsequent overt behavior likewise should be monitored and reinforced (see Burron & Bucher, 1978; Israel & O'Leary, 1973; Karoly & Dirks, 1977). It is expected

that this methodology would improve the children's awareness of the problem-solving process and make them more cognizant of the cognitive strategies' utility for improving academic performance, thereby increasing the likelihood of transfer effects (see Borkowski, Levers, & Gruenenfelder, 1976).

This article reports the results of a methodological pilot study of an academically oriented cognitive training program with stimulant treated hyperactive children. The intent was to determine whether a 10 week intervention which included self-monitoring and self-reinforcement of problem-solving behaviors, the inclusion of academic tasks, and correspondence training, would have a measurable impact on academic performance.

Performance on standardized achievement tests was of primary interest. Proficiency on an academic skills test consisting of task demands more varied than those found in standardized achievement test formats was assessed as well. To adequately evaluate the effect of cognitive training on this measure, the test was also given to a control group of hyperactive boys undergoing clinical treatment with methylphenidate.

Methods

Subjects

Study Group. The group consisted of 12 hyperactive boys receiving methylphenidate (mean daily dose = 42.08 mg, range = 10-65 mg/d) at the Child Development Clinic (CDC), a child out-patient research facility. The group's mean age was 8 years 5 months (range = 6-7 to 11-6). Their mean WISC-R Verbal IQ was 102.50 (SD=16.56), their mean Performance IQ was 101.50 (SD=12.93) and their mean Full Scale IQ was 102.17 (SD=11.89). Their mean Hyperactivity factor score on

the Conners Teacher Rating Scale (Conners, 1969) with placebo substitution was 2.31 (SD=.47); on medication their mean factor score was 0.68 (SD=.52).

Controls. The control group consisted of eight hyperactive boys undergoing clinical stimulant treatment at CDC. The controls did not differ significantly from the study group in IQ (mean VIQ = 96.4, SD=14; mean PIQ = 104, SD=15.8; mean FIQ = 99.9, SD=14.1) or age (mean = 9.2, range = 7-11 to 12-2). Their mean presenting Hyperactivity factor score of 2.09 (SD= .40) was not significantly different from the study group's mean score off medication ($t_{(18)}=1.08$, n.s.). The control group's mean daily dose of 27.5 mg of methylphenidate, (range = 20-40 mg/d), was significantly lower than the dosage of the study group, $t_{(18)}=2.16$, $p<.05$.

Study Design

To ascertain that continuation of stimulant treatment was necessary, the study children had to show behavioral deterioration at school and at home, with placebo substitution. Baseline achievement test measures, with the exception of the academic skills test developed for this study, were collected at the end of the placebo trial. Active medication was then resumed. Following restabilization, the skills test was administered and the twice weekly cognitive training sessions began. All measures were readministered at the end of this 10 week treatment period.

The control children were administered the academic skills test on medication. They were reevaluated on an alternate form of this test 10 weeks later.

Description of Training Program

During the 10 week program the study children were seen for twice weekly, individualized training sessions. Training took place

at the children's schools in rooms set aside by the teachers.

The training materials consisted of the children's current classroom work and prepared exercises taken from educational workbooks. These exercises were indexed according to specific skills (e.g., reading comprehension, handwriting, number facts, writing sentences, etc.), and task variables. These variables included instructional factors (e.g., task instructions separate from or embedded in the task layout, presence or absence of sample items, number of instructions), and type of response required (e.g., fill-in, multiple-choice, written, elimination, etc.).

The initial training sessions emphasized instructional and planning strategies. Cognitive modeling and self-instructional procedures were used to increase awareness of relevant task variables.

There was also self-instructional training in "how to be careful", with emphasis on the kinds of mistakes that could occur on a particular exercise (e.g., adding instead of subtracting, inefficient use of answer space, not considering all choices in a multiple choice problem, etc.) and strategies for avoiding these errors.

Initially, the trainers reinforced the children with checks (worth a predetermined number of points) for verbalizing instructional and planning strategy statements. As training proceeded, the children were taught to self-monitor and self-reinforce their verbalization of these problem-solving statements. Accuracy checks, with response cost (loss of points), were instituted when the child indicated familiarity with the self-monitoring format.

Subsequent sessions emphasized correspondence training. The children were required to self-monitor and self-reinforce their production of instructional and planning strategies before working and decide if there was correspondence between their verbalized strategies

and their actual performance.

When a particular content area or skill was problematic for a child, the trainer generated, with the child, a set of rules or attack strategy, which, if followed, should result in improved or correct performance. At times these rules (e.g., for two digit subtraction) were written on "reminder" cards, which the youngster could refer to when necessary.

Measures and Data Analysis

Achievement tests. The standardized tests administered were the Wide Range Achievement Test (WRAT: Reading, Spelling, Arithmetic) and the Stanford Achievement Test (SAT: Reading Comprehension, Math Application and Math Computation subtests).

The study group's baseline and posttreatment scores on these tests were compared using paired t-tests. The scores analyzed on the WRAT were standard scores; on the SAT, arcsin transformation of percentile ranks were analyzed.

Academic Skills Test. The academic skills test (AST) developed for this study was adapted from the 1978 edition of the Metropolitan Achievement Test (MAT). The baseline test content was taken from Form JS of the MAT. Posttesting content was adapted from Form KS. Choosing materials from the MAT provided alternate tests consisting of items with known and equivalent difficulty levels. The four test levels, each containing 40 items, were Primary I, Primary II, Elementary, and Intermediate. Each level was comprised of four subtests: Reading Comprehension, Math Word Problems, Math Computation, and Language.

The Reading Comprehension section consisted of three passages, totaling 15 multiple-choice questions, taken verbatim from the MAT. With minor changes, the task instructions for these passages paralleled those found on the MAT.

The Math Word Problems (three in Primary I level, five in the

other test levels) were taken verbatim from the MAT. The task demands, however, were altered. The MAT uses a multiple-choice format and instructs the children "To answer questions..., read each problem. Choose the number sentence you would use to solve the problem". The instructions on the AST were revised and read as follows: "Read each problem and check to see if it's done correctly. If it is right, put a (✓). If it is wrong, put an (X) and show how to do it". Next to each word problem a set of computations with an answer was provided. For some questions, the computations were arithmetically correct and the answer was the correct solution to the word problem. On other questions the work provided was computationally correct, but the answer was not the correct solution to the problem. Finally, on some questions, both the computations and the answer provided were incorrect. For questions with an incorrect answer, the answer was always taken from one of the four multiple choices provided in the MAT itself.

The Math Computation section also consisted of items taken directly from the MAT (12 for Primary I, 10 for the other test levels). Here too, the instructions for the multiple-choice format of the MAT were changed. Some answers were correct. Others were incorrect and were a function of one of several kinds of errors (e.g., the wrong arithmetic operation was used, there was a mistake in borrowing, there was a mistake in carrying, or there was a straight computational error concerning a number fact). As with the word problems, an incorrect answer was always chosen from among the MAT choices provided for a particular question.

The Language section for each test level consists of 10 alphabetization questions. For Primary I and Primary II, the written instructions are similar to those used in the MAT, except that on

the MAT the examiner reads the instructions to the children. Three of the Primary I and five of the Primary II questions appear on the MAT. The remaining questions consist of words taken from the reading comprehension passages in the two respective test levels. For the Elementary and Intermediate levels, the written instructions for the Language section require that each group of four words be put in alphabetical order, whereas in the MAT, the 4 item multiple-choice format instructs the children to mark the word that comes last in the dictionary. Three of the ten questions on the Elementary level are taken from the MAT, the remaining seven questions contain words found in the Elementary level reading comprehension passages of the MAT. The Language subtest on the Intermediate level of the MAT does not have alphabetization questions. Therefore, all 10 questions at the Intermediate level consisted of words found in the reading comprehension passages in the Intermediate level of the MAT.

The AST data were examined for within and between group effects. For the study and control groups, paired t-tests (two-tailed) compared the number of correct answers at pretesting with the number correct at posttesting. These comparisons were done for each of the subtests separately (because of the small number of items comprising the Math Word Problems section, scores on this subtest were combined with those from Math Computation) and for the test as a whole.

Between-group analyses, using independent t-tests (two-tailed), compared the change in the number of correct answers from pre to posttesting. These analyses were carried out on the subtest and whole test change scores.

Results

Achievement Tests

WRAT. The study group showed significant improvement in their WRAT Reading score from pre to posttesting. Their mean posttreatment standard score of 115.08 was significantly greater than their mean baseline score of 108.25, $t_{(11)} = 2.84$, $p < .02$ (see Table 1).

No significant improvements were obtained on the Spelling or Arithmetic subtests of the WRAT.

SAT. As noted in Table 1, on the Reading Comprehension subtest of the SAT the study group showed significant improvement in their mean percentile ranking; their baseline percentile of 35% increased to the 56th percentile at posttreatment, $t_{(11)} = 2.32$, $p < .05$.

No significant improvements were obtained on the SAT Math Computation and Math Application subtests.

Insert Table 1 about here

Academic Skills Test

Within-group effects. As can be seen in Table 2, the cognitively trained children showed significant improvement in their Math ($p < .05$), Reading ($p < .05$), and Language ($p < .01$) scores, as well as in their total test scores ($p < .001$). The control children did not show significant change on any of the test measures.

Between-group differences. The groups did not differ significantly in any of the pretest scores (all p 's $> .10$). Comparison of change scores indicated significantly greater improvement in the total number of items answered correctly by the cognitively trained group as compared to controls ($t_{(18)} = 2.32$, $p < .05$). On the Language section, the greater improvement demonstrated by the study children, compared to the controls, approached statistical significance ($t_{(18)} = 1.99$, $p < .07$).

There were no significant group differences in the Reading and Math subtests (see Table 2).

Insert Table 2 about here

Discussion

The aim of the current investigation was to determine if cognitive training could facilitate the academic performance of hyperactive children. Unlike most cognitive training studies with this population, academically relevant material was relied on exclusively. Moreover, the behaviors targeted for self-monitoring and self-reinforcement were substeps of the problem-solving process.

The findings provide support for the potential efficacy of this academically oriented cognitive training approach as an adjunct to stimulant treatment in hyperactive children. The cognitively trained group showed improvement in two reading skills on standardized achievement tests. Improved word recognition on the WRAT could have resulted from the program's emphasis on means of avoiding potential mistakes (e.g., mispronunciations stemming from reading too quickly). Reading comprehension skills were enhanced as well. The study children increased their relative position in this skill on the SAT from the 35th percentile at pretreatment to a posttreatment percentile of 56. Training strategies for understanding written instructions and "how to be careful" when answering multiple choice questions conceivably facilitated their performance.

Alphabetization skills were enhanced with cognitive training. On the Language section of the Academic Skills Test, 92% of the study group demonstrated improvement, compared to 33% of the controls. Group comparison of mean change on this subtest approached statistical

significance ($p < .07$). Exposure during training to search and scanning strategies was most likely instrumental in improving task performance, since accuracy on the language task requires scanning of all words, and determining the critical letter which alphabetically differentiates two or more words. Further, the study group's performance on the Language subtest suggests generalization, since alphabetization exercises were not included in the cognitive training regimen.

The cognitive program's efficacy is reflected further in the composite performance score on the Academic Skills Test. The cognitive group, but not the controls, demonstrated significant improvement in their overall performance, and the magnitude of total change in the study children was more than twice that of the control group.

Math performance on achievement tests was not improved with cognitive training. It should be noted, however, that as a group, the training children entered the study at, or close to, grade level functioning in math. The group's mean grade level was 3.3 at pre-treatment, whereas their grade equivalent scores were 3.6 on WRAT Arithmetic and 3.1 and 2.9 on the SAT Math Computation and Math Application subtests, respectively. The absence of significant change in standard scores and percentile ranks at posttreatment indicates that the children maintained their relative normative standing in math, progressing as expected for the period intervening between pre and posttesting. Given that the group was not academically backward in math and that little emphasis was placed on direct training in computational skills, the degree of change in math performance was in the expected range.

There have been reports (Brown & Sleator, 1979; Sprague & Sleator, 1977), not always replicated (Charles, Schain, & Zelniker, 1981), that

performance on laboratory measures of cognitive functioning is facilitated by relatively low dosages (0.3 mg/kg) of methylphenidate, and that higher doses may interfere with optimal functioning. In a single-subject study of the effects of dosage on academic skills, Sprague and Berger (1980) reported more efficient arithmetic performance under a lower (0.3 mg/kg) than higher dose (1.0 mg/kg) of methylphenidate. The mean daily dosage of 42.08 mg for the cognitive group in the current study was significantly higher than the control group's 27.5 mg/d (mg/kg data are not available). Nonetheless, the cognitive group performed significantly better than the controls on the Academic Skills Test. Whether greater improvement with cognitive training would have occurred under lower dosages is unknown.

Initial achievement test evaluations of the cognitive training group were done on placebo, whereas posttreatment assessments were carried out on medication. It is conceivable that the improved reading scores of the cognitive group were due in part to increased attention during posttreatment testing rather than to improved word recognition or comprehension skills. Findings on the Academic Skills Test, however, suggest that changes in drug state were not the sole contributor to improved performance, since the within-group effects and between-group differences were all obtained under active medication. Moreover, findings from several studies suggest that stimulants alone have minimal effects on reading achievement. Gittelman-Klein & Klein (1976) found that the WRAT Reading scores of learning disabled children obtained initially off medication did not improve at 12 week posttreatment testing on medication. Abikoff & Gittelman (Note 2) tested a group of 15 hyperactive children on

placebo and found no significant improvement in their WRAT or Stanford Achievement Test reading scores 16 weeks later on medication.

Although the body of evidence suggests that stimulants have little effect on academic achievement, to eliminate any potential confound resulting from changes in drug state, it would be advisable for future studies to conduct pre-post evaluations under the same drug condition.

Finally, it is possible that the improved performance of the cognitively trained children was a function of exposure to academic material, and to a lesser degree, skills training. Without a control for remedial tutoring this possibility cannot be adequately addressed. Nevertheless, the results of this pilot study are encouraging and support the implementation of controlled, large scale, random assignment investigations of the efficacy of academically based cognitive training with hyperactive children.

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Table 1

Achievement Test Performance of Cognitive Training Group

Test	Pre		Post		t^a	p
	M	SD	M	SD		
WRAT ^b						
Reading	108.25	15.73	115.08	17.28	2.84	<.02
Spelling	104.75	14.14	106.50	13.60	1.22	ns
Arithmetic	104.66	12.55	104.58	10.40	-0.01	ns
SAT ^c						
Reading Comprehension	1.25 (35%)	0.60	1.68 (56%)	0.85	2.32	<.05
Math Computation	1.24 (34%)	0.60	1.41 (42%)	0.73	0.78	ns
Math Application	1.27 (36%)	0.52	1.33 (38%)	0.71	0.24	ns

^a Correlated t tests, two-tailed; $df=11$.

^b Standard scores.

^c Arcsin transformation of percentile ranks; percentile ranks in parenthesis.

Table 2

Performance of Cognitive Training and Control Groups on Academic Skills Test

		Mean Number of Items Answered Correctly						
Subtest	# of Items	Cognitive (n=12)			Controls (n=8)			Between Groups
		Pre	Post	t	Pre	Post	t	t ^a Δ
Math	15	7.58 (2.71)	9.33 (2.31)	2.43*	9.88 (3.76)	10.88 (3.09)	1.05 ns	0.64 ns
Reading	15	8.33 (4.91)	11.33 (4.33)	2.60*	10.13 (4.26)	11.75 (3.45)	1.63 ns	0.84 ns
Language	10	3.33 (2.71)	5.67 (2.19)	3.92**	5.62 (3.62)	5.88 (2.23)	0.27 ns	1.99 ns
Total	40	19.24 (7.46)	26.33 (7.11)	5.68***	25.63 (8.71)	28.50 (8.30)	2.18 ns	2.32*

Note. The groups did not differ significantly in any of their pretest scores.

^a

Two-tailed tests; df=18

* $p < .05$

** $p < .01$

*** $p < .001$